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Harnessing social media sentiments for accuratemental health diagnosis across multiple conditions

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Abstract

Social media growth has given people a space to expose their feelings and mental health statuses. The present study explores the application of sentiment analysis in diagnosing and classifying psychological illnesses using social media posts. We identify mental health statuses such as Normal, Depression, Suicidal, Anxiety, Stress, Bipolar, and Personality Disorder by analyzing a large multi-class dataset collected from platforms like Reddit and Twitter. Data extraction was followed by pre- processing to mitigate noise and finally applying sentiment analysis algorithms in order to detect patterns. The information will be useful for creating smart tools that can help individuals with their mental problems while also tracking trends that could lead to early interventions.

Keywords: Sentimental Analysis; Social Media; Mental Health; Machine Learning; Depression

1. Introduction

Often, mental health conditions such as depression, anxiety, and stress are everywhere causing major implications for individuals and society as a whole. Social media papers are becoming central tools for analyzing these problems in order to come up with recommendations that can help patients cope [1]. Researchers can derive vital information regarding a person's emotional state by looking at user-generated content on social media platforms like Twitter or Reddit which is a critical aspect of timely identification and intervention during mental crisis episodes [2].

The procedure of sentiment analysis helps us interpret text and classify emotions which has been used successfully to ascertain mental disorders via social media postings [4]. In addition, studies done so far have made progress in this regard but there is still a need for more complete models that would recognize clearly different mental health statuses on diverse platforms [3] [4]. Therefore the goal of this research is to build an AI-based model that will be able to predict moods such as depression anxiety or even suicidal tendencies hence improving support systems for parents suffering from mental issues [2] [5].

Using modern machine learning techniques, this research aims to improve accuracy in predicting mental health and provide mental health practitioners with practical insights. [1] Therefore integrating these tools within broader healthcare strategies would result in timely interventions that are effective in improving the well-being of individuals who could suffer in silence. [6].

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1.1. Advancements in mental health assessment techniques

Previous mental health screening techniques such as clinical assessment and psychological tests have been helpful but They are time-consuming and depend on individuals' reports that do not capture the full picture of mental health disorders [2] [7]. Over the past few years, concepts such as big data and machine learning have provided different ways to approach the assessment of mental health. Sentiment analysis, a case of emotion interpretation from text data, has been applied to social media posts to identify symptoms of mental health disorders. It can provide up-to-date trends in mental health by analyzing posts on social media such as Twitter and Reddit [8] [5].

However, to address the previously mentioned challenges, there is a necessity for more extensive models capable of evaluating numerous forms of mental health disorders. The purpose of this analysis is to advance artificial intelligence models that can precisely diagnose different mental health con- ditions, thus improving the effectiveness of early intervention [9] [10].

1.2. Research aims and objectives

The main goal of this research study will be to establish artificial intelligence models that effectively and accurately diagnose mental health conditions by analyzing sentiments on social media. [11] This paper aims to improve the prevention plan to facilitate the early diagnosis of mental disorders [12].

Some of the goals include obtaining and processing large datasets from social media platforms, designing effective algorithms for the classification of mental health statuses, and evaluating the effectiveness of the solutions. Further, the research's objectives include determining the current trends of mental health expressions in social media platforms and directions for applying these models to current and future mental health paradigms [13].

2. Methodology

2.1. Dataset collection

For this research, data sourced from Kaggle datasets include the 3k Conversations Dataset for Chatbot, Depression Reddit Cleaned, and Human Stress Prediction datasets. Moreover, in an effort to obtain user feedback from a varied population. This approach helped to use and update the existing data together and collect the primary data for Mental Health Statuses; Normal, Depression, Suicidal, Anxiety, Stress, and Personality Disorders. [14]

Decision Trees: Decision Trees were utilized to classify the sentiment in social media posts. Decision trees basically provide insight into the decision-making process, where the data is divided into subsets that depend on the feature values. This is explained in [8].

Logistic Regression (LR): Logistic Regression analyzed the features of social media data associated with different mental conditions. LR provides an insight into how certain features contribute toward sentiment classification, discussed in [5].

Na¨ıve Bayes: NB finds an abundant application due to the simplicity and efficiency of this algorithm while handling voluminous datasets. The features are considered independent by this model, and it was implemented for text data analysis in sentiment classification, which is referred to in. [16]

Gradient Boosting Machine (GBM): The boosting algo- rithm of GBM is effective, combining a set of weak models into a strong predictive model, which is the reason why GBM is performed. Performance and utility of GBM in sentiment analysis are presented in reference. [10]

These models are implemented using key attributes like "Statement" and "Mental Health Status" to analyze and predict outcomes effectively within the dataset.

Attribute	Description
Statement	User feedback on thoughts and feelings related to mental health, providing qualitative insights into individual experiences.
Mental Health Status	Overall assessment of mental well-being based on self-reported data and standardized indicators, categorized as Normal, Depression, Suicidal, Anxiety, Stress, or Personality Disorders.

Figure 1 Category-wise detection By Decision Tree

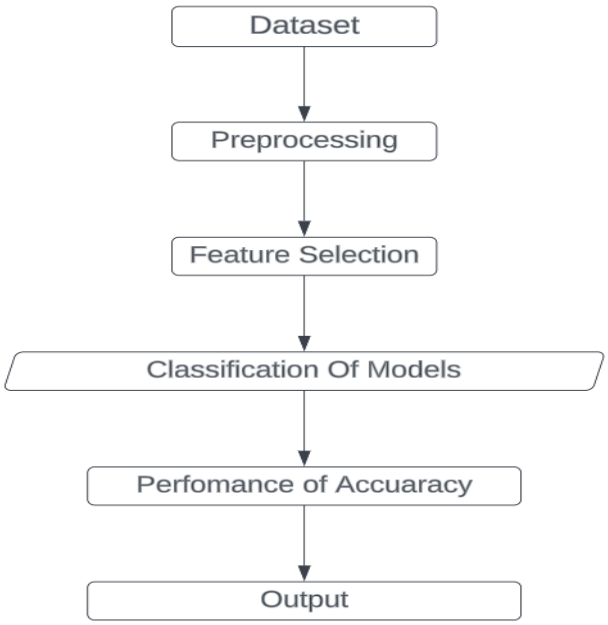

Figure 2 Flowchart of model working

2.2. Machine Learning Models

1) Support Vector Machine (SVM): Support Vector Ma- chine SVM was applied because of its ability to handle high dimensionality data and, at the same time, perform very well in classifying sentiments when the classes are well separated by a clear margin. In [7], the performance of SVM in sentiment classification was studied. [15]

3. Literature review

Another study that has been done on sentiment analysis relates to the detection of emotions such as anxiety and depression on social media [17]. While useful when identifying such emotions, many such implementations are limited in their general utilization spanning multiple mental health states, with most research conducted on precise conditions or data sets [2], [5].

Existing models often tend to base themselves on data collected from only one platform and therefore have limited capability and precision. [18] Despite the fact that some conditions including bipolar disorder are generally not well researched, [19]this study has indeed progressed and covered a wider category of mental health conditions that included Normal, Depression, Suicidal, Anxiety, Stress, Bipolar, and Personality disorders [7], [9].

3.1. A. Gaps in the Literature

Despite advancements, gaps remain. Most research is lim- ited by confining data collected to certain conditions and social media platforms, hence predisposing the results towards a certain bias. This research was carried out to avoid the mentioned limitations and create models that would include data from different platforms and are concerned with the wider number of mental health issues. [20]

4. Results

4.1. Comprehensive Data Depiction

In this study, 10,537 instances were analyzed to evaluate machine learning models for predicting seven mental health conditions: These are Normal, Depression, Suicidal, Anxiety, Stress, Bipolar, as well as Personality Disorder. The models used were SVM and Naive Bayes and the visuals below high- light the categories distribution and the models performance. [18]

4.1.1. SVM Model Performance Visualization

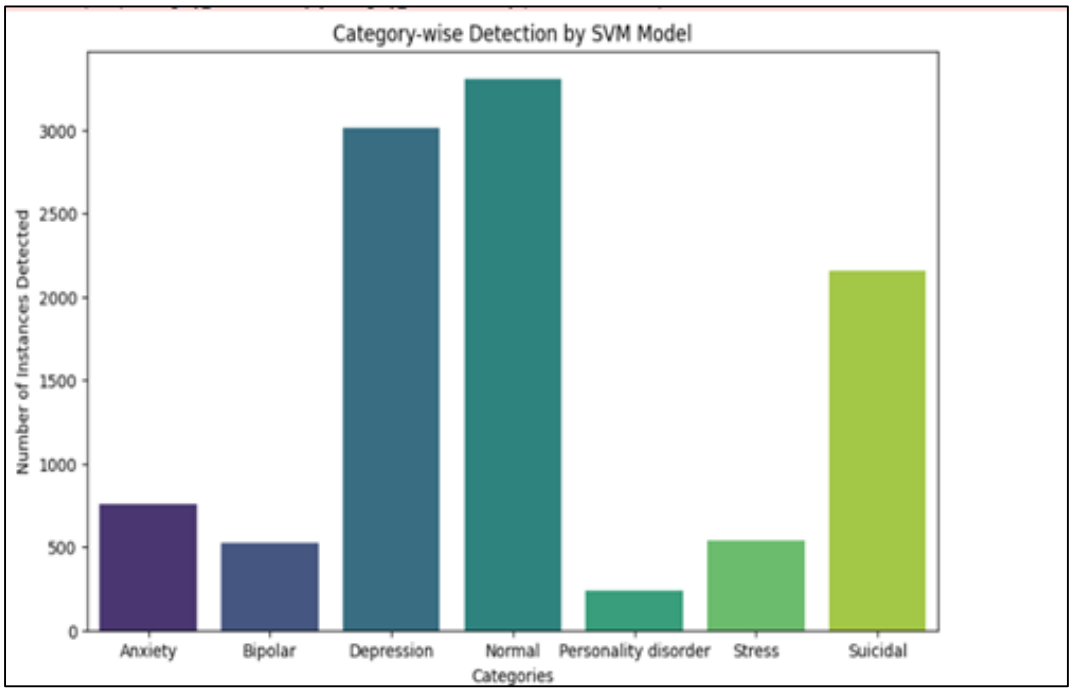

Figure 3 Category-wise Detection By SVM Model

The bar chart reveals that the SVM model had high detection rates for 'Normal' at 3,308, 'Depression' at 3,016, and 'Anx- iety' at 755 instances, revealing the highest accuracy over all the five models tested. Even though for 'Personality Disorder' and 'Stress', they received lower accuracy value altogether the proposed SVM model fared better compared to all other models for the classification of these conditions.

4.1.2. Naive Bayes Model Performance Visualization

The heat map of the Naive Bayes model indicates that the model has a relatively lower accuracy than the other five models that have been considered. While identifying 'Anxiety,' it flagged 2,654 cases and 'Depression,' 2,457 cases, but misclassified 'Normal' (445 cases) and 'Personality Disorder' (1,154 cases). The accuracy of the model in categorizing the posts as 'Suicidal' (2,000) 'Bipolar' (1,000) and 'Stress' (500) was also relatively poor suggesting that further fine- tuning of the model may be necessary for better classification in these categories.

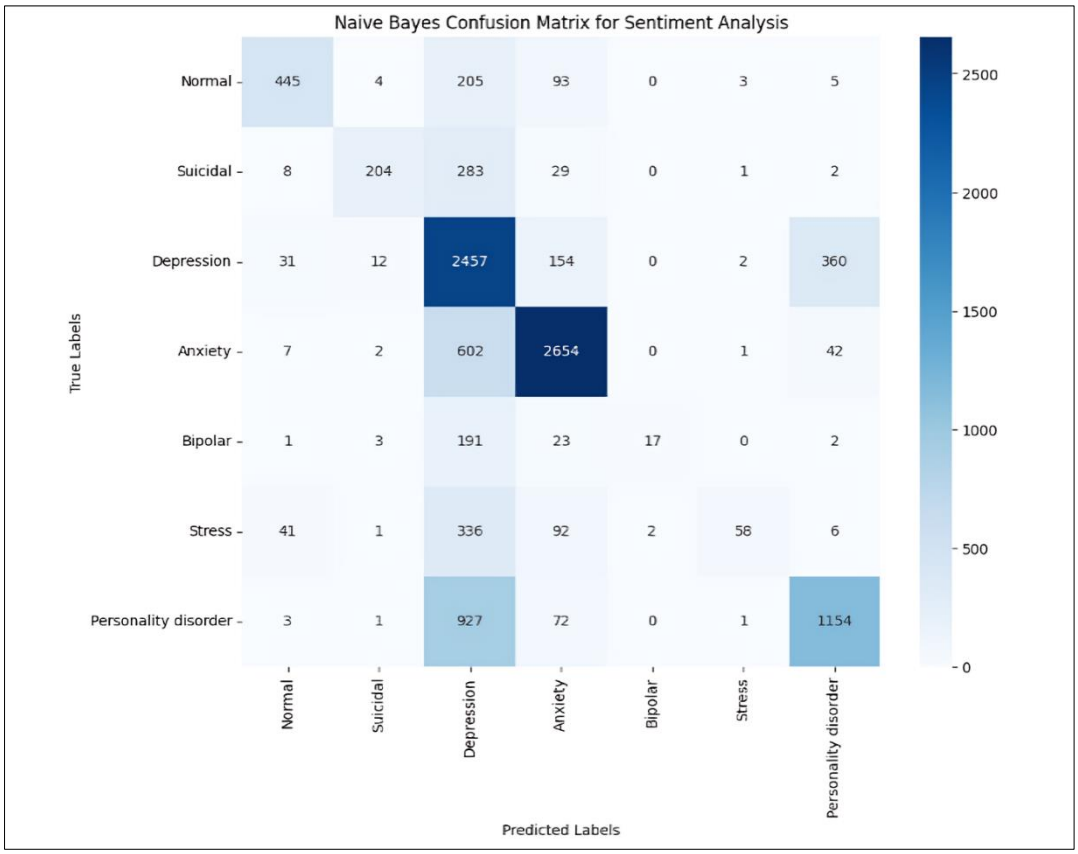

Figure 4 Naive Bayes Confusion Matrix

4.1.3. Logestic Regression Performance Visualization

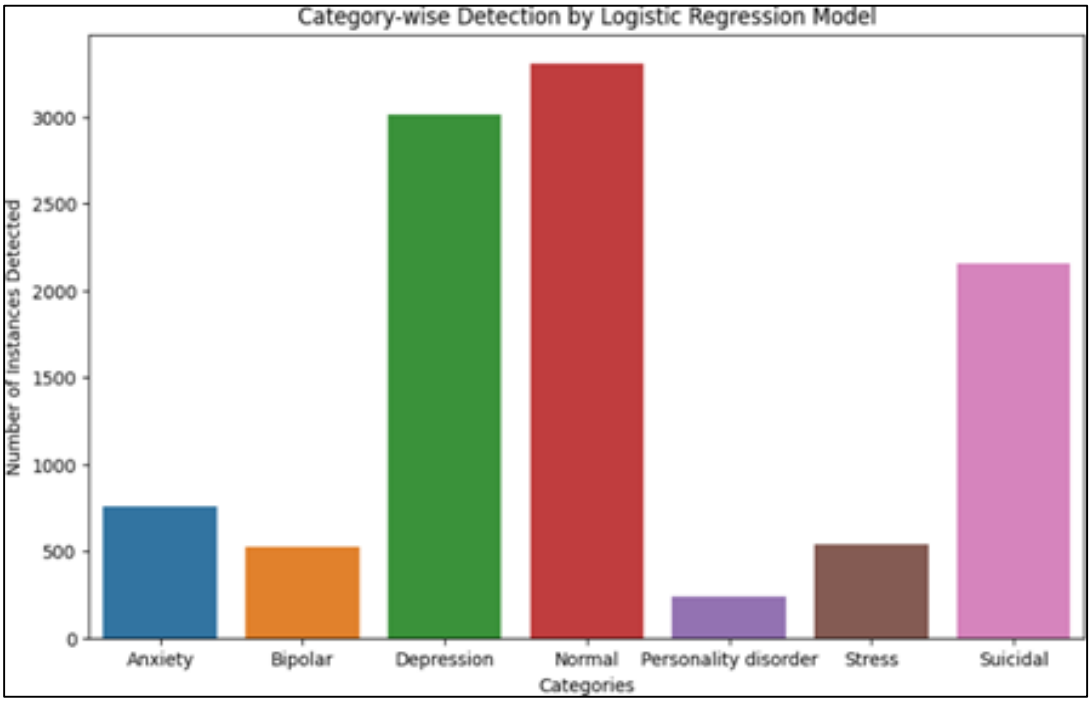

Figure 5 Category-wise detection by Logestic Regression

The bar chart illustrates the distribution of instances de- tected by a Logistic Regression Model across various mental health categories. The ”Normal” category has the highest number of detections, indicating that a significant portion of the dataset was classified as non-mental health conditions. This is followed by ”Depression” and ”Suicidal,” which also have a substantial number of instances, suggesting that these condi- tions were commonly identified by the model. The ”Anxiety” and ”Stress” categories have a moderate number of detections, reflecting their presence in the dataset, while ”Bipolar” and ”Personality Disorder” have the lowest number of detections, indicating that these conditions were less frequently classified by the model. Overall, the chart highlights the model’s ten- dency to detect certain mental health conditions more often than others.

4.1.4. Decision Tree Model Performance Visualization

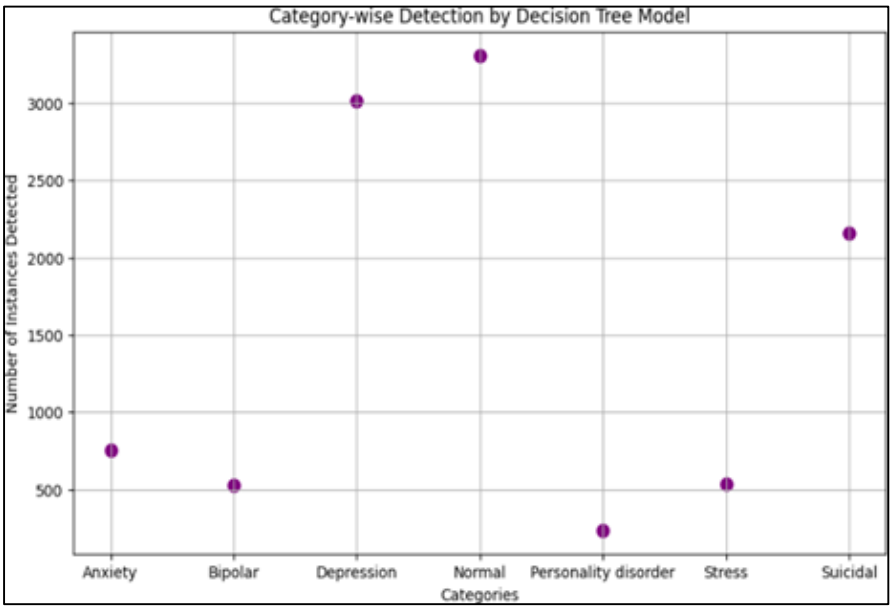

Figure 6 Category-wise detection By Decision Tree

The scatter plot shows how a Decision Tree Model identifies different mental health conditions. Most often, the model detects people as ”Normal,” followed by a high number of detections for ”Suicidal” and ”Depression.” On the other hand, conditions like ”Personality Disorder,” ”Bipolar,” and ”Stress” are identified much less frequently. ”Anxiety” falls somewhere in the middle. This suggests that the model is more likely to classify cases as either normal or serious mental health issues like depression or suicidal tendencies, while it struggles to detect some other conditions as often.

4.1.5. GBM Performance Visualization

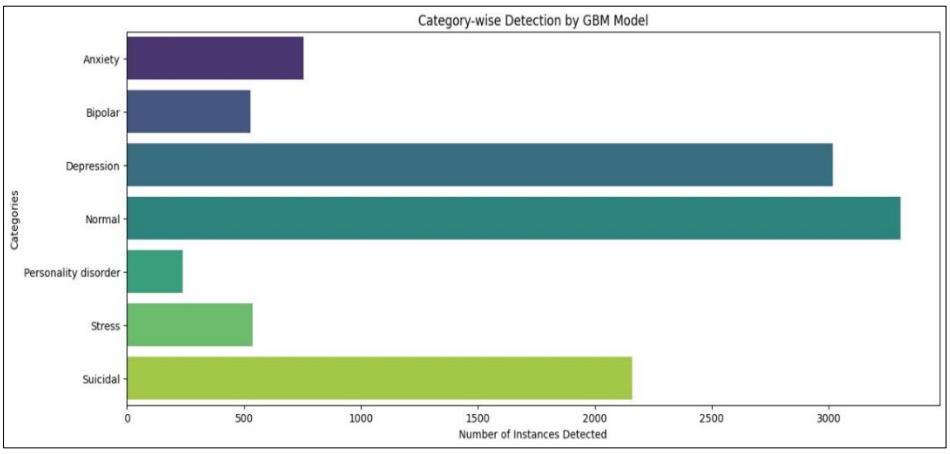

Figure 7 Category-wise GBM model

The bar chart shows how a GBM Model identifies various mental health conditions. The model tends to classify a large number of cases as ”Normal,” indicating that many individuals in the dataset were identified as not having a mental health condition. Beyond this, it also frequently detects ”Suicidal” and ”Depression” cases, suggesting that the model is particu- larly tuned to recognizing these serious conditions.

On the other hand, the model is less consistent in identifying ”Anxiety” and ”Bipolar” conditions, catching these cases but not as frequently. ”Stress” is detected slightly more often but still lags behind the top categories. The least detected condition is ”Personality Disorder,” which might indicate that the model has difficulty recognizing this condition, possibly due to its complexity or lower prevalence in the dataset.

Overall, the chart reveals that while the model is effective at spotting more common or severe mental health issues like normal behavior, depression, and suicidal tendencies, it may require further refinement to better detect and differentiate less common or more nuanced conditions like personality disorders, anxiety, and bipolar disorder.

5. Discussion

The table below compares five machine learning models using four attributes: Accuracy, Precision, Recall, and F1- Score (all macro averaged). Accuracy indicates overall correct- ness, Precision measures the accuracy of positive predictions, Recall captures the model’s ability to identify all positives, and F1-Score balances precision and recall to reflect overall performance. [21]

Model	Accuracy	Precision (macro average)	Recall (macro average)	F1-Score (macro average)
SVM	0.7802	0.79	0.70	0.74
Naive Bayed	0.6633	0.80	0.47	0.52
Logistic Regression	0.7731	0.79	0.68	0.72
Decision Tree	0.6609	0.60	0.59	0.59
GBM	0.7530	0.77	0.66	0.70

Figure 8 Model Performance Comparison

5.1. Accuracy

It can be observed that SVM has the highest accuracy at 0.7802; hence, it is very reliable for the proper classification of instances. Logistic Regression follows closely with an accuracy of 0.7731, while GBM performs decently with an accuracy of 0.7530. Naive Bayes and Decision Tree have lower accuracies with 0.6633 and 0.6609 respectively and are bound to make more errors.

5.2. Precision (Macro Avg)

The precision is best for Naive Bayes with 0.80, indicating high correctness when it predicts positive cases. SVM and Logistic Regression both have 0.79, which is a very good score with respect to precision. GBM is somewhat behind at 0.77. The Decision Tree is the worst, with 0.60, meaning there is less precision in predicting positive cases.

5.3. Recall (Macro Avg)

The SVM provides the best recall at 0.70, which means most positive cases are predicted. Logistic Regression follows at 0.68 and GBM is at 0.66. Decision Tree is relatively lower with 0.59 recall, while Naive Bayes barely attained 0.47 recall and missed many positives.

5.4. F1-Score (Macro Avg)

For the best model, in terms of F1-score, the best perfor- mance is SVM with a score of 0.74, thus showing the best balance between precision and recall. This is followed by Logistic Regression at 0.72, whereas GBM scores 0.70. On the other hand, the F1-Score is at a low of 0.59 for Decision Tree, while the poorest performance in terms of maintaining an equilibrium between precision and recall goes to Naive Bayes at 0.52.

6. Conclusion

In conclusion, this study demonstrates that it is feasible to mitigate the challenges associated with analyzing social media content for mental health assessment and that machine learning models, particularly Support Vector Machines (SVM), provide high accuracy in identifying and predicting a range of mental health disorders through sentiment analysis. The research highlights that the SVM model outperforms the Naive Bayes model in terms of diagnostic accuracy, particularly for conditions such as depression, anxiety, and bipolar disor- der. These findings underscore the importance of integrating multiple data streams to enhance the evaluation of mental health, suggesting that the optimization of machine learning algorithms can significantly contribute to the early detection of mental health issues. By refining these models, the study paves the way for the development of more effective tools that can aid in better mental health management and early intervention, ultimately leading to improved mental health outcomes.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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